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ABSTRACT

This paper reports on an experiment in mathemagenic behavior ("Student inspection and processing activities that give birth to learning") as related to second-language vocabulary learning. The experiment was designed to determine whether visual mnemonics are more effective than unelaborated rehearsal technique for learning FL vocabulary, and whether a given visual mnemonic is more effective than one invented by the student. Seventy-five Spanish-language students with no prior training in German were randomly assigned to one of five groups, whose task was to learn the meaning of 24 German words as they were pronounced by native speakers. As each German word was pronounced on tape, the English meaning was flashed on the screen plus a mnemonic phrase. Group MG was told to use the mnemonic phrase in learning the word meanings; Group A was told to use a specific algorithm; Group A-8 was told to make up original algorithms; Group R was instructed to repeat the word and its meaning silently as many times as possible; Group C, the control group, was told to use any method. All groups were allotted 12 seconds per word except Group A-8, which had 20. A learning text was administered immediately after the instruction session, followed by a questionnaire and then by a retention test. A major conclusion is that strategies involving verbal or visual mnemonics were considerably more effective than a repetition technique, and that a self-generated visual mnemonic is more effective than a given one. (AM)

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COGNITIVE SCAFFOLDING IN THE LEARNING OF FOREIGN LANGUAGE VOCABULARY AN EXPERIMENTAL STUDY *

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Cognitive Scaffolding in the
Learning of Foreign Language Vocabulary
An Experimental Study

Introduction

A serious problem which confronts the student of a foreign language is the sheer magnitude of the memory task involved in acquiring thousands of new words in a relatively short span of time. While foreign language teachers and instructional designers have given great attention to the linguistic and situational content of second language instruction and to the organization and sequencing of instruction, little attention has been given to the student behaviors which lead to efficient processing and retention of the mass of material that is presented.

The importance of looking at student behavior that facilitates learning is illustrated by Ernst Rothkopf's paraphrase (1970) of an old proverb: "You can lead a horse to water, but the only water that gets into his stomach is what he drinks." The "not-drinking horse" is the student who has failed to learn effective strategies for inspecting and processing the information that he is given. Rothkoph has coined the word mathemagenic to refer to student inspection and processing activities that give birth to learning. According to John Carroll (1970), "The promotion of mathemagenic activities on the part of the student should be considered one of the teacher's most important functions." It seems, then, that teachers and instructional designers ought to look beyond the content of the instruction itself to see what kinds of information or types of strategies stimulate effective learning behavior.

One type of strategy that promotes effective learning behavior in a variety of contexts involves the use of mnemonics or memory aids. Mnemonics have a long history of use dating from the time of the Greeks but only recently have these techniques been systematically studied in theory of oriented research. Bugelski (1968) compared a mnemonic technique with rote rehearsal instructions for learning lists of words by ordinal position. The criterion task was recalling the appropriate noun when the number of the word on the original list was read in random order. Performance was significantly improved when subjects were instructed to form mental pictures linking the words to be learned with a concrete noun rhyming with the number of its position on the list such as one-bun, two-shoe, three-tree, etc. Thus a person learning a list beginning with the words scissors, lemon, blanket, might form mental images of scissors cutting a bun, a lemon in a shoe, and a blanket covering a tree. In another context, Prytulak (1971) found that meaningful natural language mediators were consistently reported by persons learning nonsense trigrams. Thus a person might learn the trigrams FBJ and PYN by thinking of ELBow Joint and Pin-with-a-y.

Behaviorist psychologists of the Skinnerian school have often viewed vocabulary learning as a rather simple type of stimulus-response learning, which requires repetition in the presence of the criterion stimulus and reinforcement of correct responses. However, cognitive psychologists such as Ausubel (1968) suggest that long term retention in memory depends not upon rote rehearsal but upon integrating that which is to be learned into existing

cognitive structure in a meaningful manner. Just what does this mean in the case of learning foreign language vocabulary? A task with similar requirements that has been extensively studied by psychologists is the artificial task of learning noun pairs such as tomato - pin, rock - bottle, tire - handkerchief so that given one member of the noun pair as a stimulus a person can give the other as a response. According to Rohwer (1973), the critical determinant of performance in this type of learning task is "whether or not the subject generates an event as a common referent for each pair of nouns." This event is some episode, process, or relation involving both members of the pair "such that its identity would be altered if either of the objects or topics were deleted." Since the analogue of a noun-pair in foreign vocabulary learning is the foreign expression and its meaning, we would expect an effective mnemonic device to be a mental event created by the student which involves both.

This process of generating a common referent for items to be coupled is labeled by Rohwer by the term elaboration. Elaboration serves as a kind of cognitive scaffolding which supports the erection of the new mental structure required to link the two members of the pair in a meaningful manner. For example, a student might remember that the German word kohl means "cabbage" by thinking of cole-slaw, a mnemonic which refers both to the sound of the foreign word and its meaning.

There has been some investigation of mnemonics reported in the second language literature, but the results of such efforts have not been consistently

positive. In an experimental study of foreign vocabulary learning, Robert Lado and his associates (1967) compared the effect of providing a mnemonic device with embedding the word in a connected sequence involving either an element of suspense or a factual report, or simply repeating the meaning of the word. The fact that no statistically significant differences were found for any of these variations in context would seem to discourage further investigation of mnemonics in second language learning. However, neither of the two types of mnemonic devices employed in the experiment provided any information that could assist the student in the crucial task of linking together the acoustic signal of the Spanish word and its meaning.

One type of mnemonic was simply to provide the student with a geographical place name starting with the same sound as the foreign word. For example, the student learning the Spanish word for "drinking horn," cacha, was told to associate it with Kashmir. The other type of mnemonic device supplied the student with a familiar word which referred to the meaning in some way. For example, the student learning that Spanish abarrotar means "to overcrowd," was instructed to associate the meaning with closet. Note that Kashmir relates only to the sound of cacha, and closet relates only to the meaning of abarrotar. Quite different results might have been found in such an experiment if, for example, the students had been told to remember the meaning of cacha by imagining someone catching beer in a drinking horn, saying "caught 'cha, beer;" or if they had been instructed to remember the meaning of abarrotar by visualizing a bar o' tar (overcrowded because many

are stuck to it).

In the previously mentioned task of learning noun pairs, one kind of elaboration is forming a mental picture of the referents of the two nouns interacting in some way. For example, for the pairs tomato-pin, rock-bottle, students might visualize a pin sticking into a tomato, and a rock breaking a bottle. In a study by Bower (1970), interactive imagery instructions nearly doubled the percentage of correct recall of the response term compared with either rote rehearsal instructions or instructions to form separate images of the referents of the concrete noun pairs.

It is this type of mathemagenic behavior which was investigated in the experimental study conducted by the authors. But in this experiment, instead of learning an arbitrary association between pairs of nouns in one's native language, the task was to learn the meaning of German words as they were pronounced by a native speaker. This requires that elaboration be found between elements, one of which has for the native learner very little imagery potential, the foreign word. The research by Prytulak (1971) referred to earlier indicated that in acquiring low meaningful trigrams learners characteristically generate natural language mediators which are relatively high in image potential. Thus associating native language glosses to new foreign language terms requires two stages if the learner is to form effective elaboration. First he must transform the foreign language sound into a related word in his own native language. Secondly, he must create an elaboration which integrates the sound equivalent mediator and the gloss.

These two steps provide the cognitive scaffolding for forming a new mental structure which relates closely to the learner's existing cognitive structure.

The process of generating imagery or visual elaboration in a foreign language setting can be described in the following steps:

1. As you hear (or read) the foreign word, think of an English word which sounds like it. For example, German mass sounds like "moss" and German scheit sounds something like "sheet."
2. Form a picture in your mind which ties together the meaning of the foreign word and the English word which sounds like it. Since scheit means "log" you might envision a log wrapped in a sheet.
3. Sometimes the sound-a-like word and/or the meaning will not be easy to visualize. When this happens, choose a closely related word which can be easily visualized. Since mass means "measure," you might visualize a yardstick covered with moss.

It is essential that the mental picture tie the two items together into a single scene. In this manner, a mental event is generated which, in Rohwer's terms, "can serve as a common referent for the members of each pair."

This experiment was designed to answer the following specific questions with respect to the type of mnemonic which has just been described: (1) Is a learning strategy based on the use of visual mnemonics more effective than an unelaborated rehearsal technique for learning foreign language vocabulary?

(2) Will providing the student with a specific visual mnemonic for each word be more effective than having him invent his own?

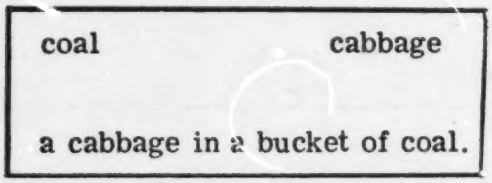
Method

Subjects and Materials

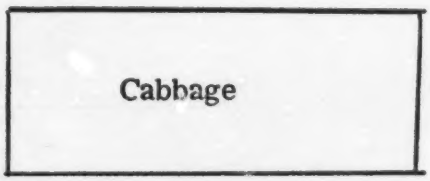
The subjects who participated in this experiment were 75 young missionaries involved in an intensive two-month course in Spanish at the Language Training Mission of the Church of Jesus Christ of Latter-day Saints in Provo, Utah. Most of them had had previous foreign language training in high school or college, but none had had prior training in German, the language used in the study. As the subjects arrived for the experiment, they were randomly assigned to one of five treatment groups by means of cards which had been previously arranged in a random order.

The major task of the experiment was learning the English gloss of 24 one-syllable German words which had been recorded professionally by a native speaker. The words included both nouns and adjectives, and were selected according to the ratings of a panel of ten judges to represent equivalently both words phonetically similar to English such as German Leim or Kohl as well as phonetically dissimilar words such as Fürst or Qualm. The 24 words also included equal numbers of the words judged to be highly imageable such as the German words for "tooth" and "poppy" and those judged difficult to picture such as the German words for "homage" and "true." No cognates were included.

As each word was pronounced on the tape during the experiment, the English meaning of the word was flashed on the screen. In addition to the English gloss, the slides for one of the five groups contained a mnemonic phrase. For example, the following slides were shown for the German word Kohl "cabbage":



For Group MG



For Groups A, A+8, R, C

Treatments

Each of the five groups was instructed to learn the German words by a different method. Group MG (Mnemonic Given) was told to use the mnemonic phrase in the middle of the slide to form a mental picture which linked together the meaning of the German word and the English word which sounded like it. Group A (Algorithm Group) was given a specific algorithm for forming their own interactive imagery mnemonics and told to use this method for learning the German words. This algorithm was essentially the same as that given in the introduction of this paper. All groups were given exactly 12 seconds for learning each word except for Group A+8 which was given an extra 8 seconds. The treatment for Group A+8 was in all other respects identical to that given Group A. The comparison of the Mnemonic-Given group with the two Algorithm groups was designed to test whether providing an interactive imagery mnemonic

is more effective than having the student invent his own. Since a previous pilot study with 10 subjects had shown that it required an average of 8 seconds for students to invent their own mnemonics of this type, it was felt a longer interval for Group A+8 would equate learning time with mnemonics to that of the Mnemonic-Given Group. Group R (repetition group) was instructed to learn the words by silently repeating the German sound and the English meaning together in their minds as many times as possible. For example, if they heard the German word arg on the tape and saw the meaning "bad" on the screen, they were instructed to repeat "arg-bad," "arg-bad," silently until the tape went on to the next word. The comparison between the three mnemonic groups (MG, A, A+8) and the Repetition Group (R) was designed to test whether a learning strategy based on the use of interactive imagery mnemonics is more effective than an unelaborated repetition technique. Group C (Control Group) was told to use any method they desired to learn the meanings of the German words. Each group was given an equivalent opportunity to practice their particular method with several German words before beginning the instructional treatment. Then the 24 words were presented in random order to the five treatment groups.

Procedure

1. As the 75 subjects arrived at the appointed hour for the experiment, they were randomly assigned to one of the five identical rooms in the same building for the presentation of the five experimental treatments.

2. Instructions for learning the German words and appropriate examples were given via tape recording and written handout after which all Ss had an opportunity to practice with 3 German examples presented at the same time interval as the actual learning items. After each example, Ss were asked if they had learned the German word using the particular method they had been instructed to use.
3. Each group listened to the 24 German words on a tape while seeing corresponding slides which presented the meaning and, in the case of the Mnemonic-Group only, a mnemonic phrase. There was a 12 second interval between items for all groups except Group A+8 for which the interval was 20 seconds. During the prescribed interval, the item number was read and then the German word was pronounced twice with a brief pause in between.
4. A learning test was administered immediately following the instructional treatment. The subjects were given a numbered sheet of paper and told to write down the meaning of all the words they could remember. They listened to the 24 German words at 12 second intervals with each word repeated twice. The list of words was in a different random order than the instructional sequence.
5. As an interference task following the learning test, Ss completed a questionnaire which asked about previous foreign language training, their experience in learning Spanish, their opinion of the particular method they had been instructed to use for learning the German words

etc. Eight minutes were alotted to each group for this task. At no time were they forewarned that there would be a retention test on the German vocabulary.

6. A retention test was given by tape to all groups. This test was identical to the learning test except for a random reordering of the items.

7. As the final task of the experiment, all Ss filled out a report on how they remembered each German word. By each of the 24 words and its meaning, they were asked to check the dominant method they actually used for learning the word and to describe the specific memory device they used to learn the meaning. They checked one of the following categories on the chart: (1) Did you repeat this word and/or the meaning over and over to yourself? What specifically did you repeat? (2) Did you form a mental picture in which you could visualize something that reminded you of the German word and its meaning? Describe the specific mental picture you used. (3) Did you think of a sentence or word which somehow reminded you of the German word or its meaning? What specific word or sentence did you use? (4) Don't remember.

Results and Discussion

Following the experiment, it was found that the random assignment of subjects had not fully succeeded in equating the treatment groups with respect to average language aptitude as measured by the Modern Language Aptitude

Test. Thus in the statistical analysis of the data, scores on the Modern Language Aptitude Test and Years of Previous Language Experience were entered as covariates and all means were adjusted for the effect of these two factors. Since scores on the MLAT test were not available for a few of the subjects in each group, data for 12 of the 75 original subjects was not considered in the analysis.

The adjusted means for the two 24 item tests are presented in Table 1. An anslysis of covariance for an unbalanced design was performed on the data and the adjusted means for treatments were found to differ significantly on both the learning and retention tests ($p < .01$). Once the significance of the treatment differences was determined, pairs of treatment means were compared using simple t tests. On the learning test, (the Mnemonic) group A+8 which had extra time, performed significantly better than any other group ($p < .01$). The two other Mnemonic groups (MG, A) and the Control group (C) were all significantly superior to the Repetition Group ($p < .01$) but did not differ significantly from one another. On the retention test, however, a different pattern emerged. On the second test, both the Mnemonic Group A+8 and the Control Group performed significantly better than any other group ($p < .01$) but did not differ significantly from one another. The two other mnemonic groups were again significantly superior to the Repetition Group ($p < .01$) but did not differ significantly from one another.

One major conclusion which can be drawn from comparing the three mnemonic groups (MG, A, A+8) with the Repetition group (R) is that a

Table 1
Adjusted Mean Scores for Experiment 1
(maximum = 24)

Group	Tests	
	Learning	Retention
MG	8.64	7.12
A	9.08	8.54
A+8	13.55	14.07
R	4.38	3.78
C	9.38	12.46

learning strategy based on the use of interactive imagery mnemonics is superior to an unelaborated repetition technique. If one compares the repetition group with the control group, repetition without elaboration actually interferes with learning rather than assisting it.

By comparing the Mnemonic-Given Group and the Mnemonic group A+8 it can also be concluded that a self-generated visual mnemonic is more effective than supplying a mnemonic phrase, provided sufficient time is given for the extra mental processing which is required. It may be that effective elaboration is a highly individual, idiosyncratic process and that some of the facilitating effect is related to the added cognitive processing required to invent one's own mnemonic of this type.

Data from the self-reports was useful in determining what learning strategies subjects actually used for individual words irrespective of the method they were instructed to use. The percentage of "correct" answers remembered by different methods is reported in Table 2. This chart was tabulated by matching the correct items on the two tests with the specific learning strategy which individual subjects reported using for learning the item.

For the three mnemonic groups (MG, A, A+8), a much greater percentage of words were remembered by using visual mnemonics than any other method. This, of course, is not surprising since these groups were specifically instructed to use this method.

Table 2
Percentage of Correct Answers
Remembered by Different Methods

Method	Group				
	MG	A	A+8	R	C
Learning Test					
Repetition	2	2	2	28	16
Visual Mnemonic	87	68	71	26	20
Verbal Mnemonic	5	25	13	37	35
Don't Remember	6	5	14	9	29
Retention Test					
Repetition	3	3	3	24	18
Visual Mnemonic	85	73	70	35	21
Verbal Mnemonic	6	19	15	37	31
Don't Remember	6	5	12	4	30

An outcome of the experiment which was initially very surprising was the high-level performance of the Control Group which was instructed to use any method they desired. However, inspection of the strategies this group used for the words they mastered, shows that methods Ss generated involving verbal or visual mnemonics were considerably more effective than a repetition technique. It must also be noted that the great majority of the subjects in the experiment were experienced language learners who had had considerable opportunity to develop effective strategies of their own. Most had had 1 to 4 years of previous foreign language training in addition to 5 or 6 weeks of intensive training in Spanish at the Language Training Mission. It is significant that most of the effective learners in the Control Group were using either verbal or visual elaboration even though they were free to use any method they wished. Even in group R which was specifically instructed to use an unelaborated repetition technique, the majority of the words were reported remembered by using some type of elaboration.

In a later replication of this experiment by Ott, Blake, and Butler (1973), subjects with more than three years of previous language training or with training within the last two years were screened out before assigning subjects to the treatment groups. In this second experiment, subjects in the Control group performed no better than the Repetition Group and both were significantly inferior to the Groups using Mnemonics. The superiority of the Mnemonic groups held up in the replication study even on a delayed retention test given with no warning two weeks after the initial instruction and testing. See

Table 3.

Some language teachers of an audio-lingual persuasion may argue that a student learning vocabulary through the kind of cognitive processing outlined in this paper will have to go through the same time-consuming steps every time he wishes to use the word. However, Merrill (1971) indicates that learning which takes place on a high cognitive level is later "pushed down" to a lower habit level as the learner repeats the behavior. Thus mnemonics used in the learning process will not be required once the behavior is firmly established. The once useful cognitive scaffolding provided by the mnemonics is taken down, and the automatic use of the language should not be impeded.

Table 3
Mean Scores for Experiment 3
(maximum = 24)

Group	Tests		
	Learning	Retention	Delayed Retention
MG[a]	12.9	12.3	6.1
A[b]	9.2	9.1	5.6
R	5.8	4.7	1.9
C	5.1	5.1	2.4

[a] Actual pictures were supplied in Experiment 2 instead of mnemonic phrases. For example, Ss learning the German word Kohl "cabbage" saw a slide showing a line drawing of a cabbage in a coal bucket instead of seeing the phrase "a cabbage in a bucket of coal."

[b] The algorithm group with extra time was not included in Experiment 2.

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